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DESIGN AND USES OF AN AUDIO/VIDEO STREAMING SYSTEM FOR STUDENTS WITH DISABILITIES

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Within most educational institutes there are a substantial number of students with varying physical and mental disabilities. These might range from difficulty in reading to difficulty in attending the institute. Whatever their disability, it places a barrier between them and their education. In the past few years there have been rapid and striking advances in commercial audio/video/computer technology. But it seems that often, these advances are not applied within the assistive technology sector or only on a very limited basis. Part of the reason for this may be lack of awareness and knowledge of the technologies and lack of understanding as to how they may be employed to benefit students with disabilities. This article hopes to touch on just a few of the areas where cheap, off the shelf products can be combined in an assistive technology role. The system and applications discusses do not require a high degree of technical skill to set up or maintain. Described here are the methods of deploying audio/video-streaming technologies that can be used as an integrated and fundamental tool to assist disabled students in their everyday education, from access to reading material to video conferencing with lecturers for students who cannot attend the institute. The article does not aim to give an in depth analysis of the technologies, rather a brief introduction to their use and a feeling for how the may be deployed. Firstly, a description of how texts can be recorded to computer and from there to a streaming audio/video library is given. From this basic system it is easy to expand its capabilities to include video streaming of lectures, both live and recorded.A description of the standard web page interface that can be used by sighted and blind students is provided. How the system can be replicated in a number of educational institutes and how all these system may be linked into a national/international audio/video library for texts and lectures is then discussed. A brief description of two alternate user interfaces suitable for students with limited physical mobility are described. A brief description of how video conferencing can be used to give students, who cannot attend the institute, access to seminars and lecturers is given. An overview of various organisational challenges is presented. Finally, a conclusion is given.

Audio/Video Library

The overall aim of the following procedures is to develop a streaming audio/video library on which audio books and video recordings of lectures are stored. This library can be accessed from within the institute or from anywhere through the Internet. In this way, students who cannot attend the institute may still be able to access much of the educational material related to their course of study.

Obviously, recordings of books will be of no use to deaf students, but will be of use to vision impaired or physically disabled students.Recordings of lectures can be subtitled and supplemented with additional commentary to describe graphs, images, etc, making them accessible to the widest range of students as possible.

Recording Audio to Computer

The first step in recording a text so that it can be streamed across the Internet/intranet is to have a reader record it to a more traditional medium, typically this has been an audio cassette. It however has many drawbacks. The quality of the recording is often poor, is easily damaged and subject to degradation over time.

A more suitable medium is the minidisc. Recordings on minidiscs will not degrade over time. The recording is of very high quality and with the use of appropriate microphones there is very little background noise. Minidisc recorders/players cost around $200 (all costs in $US) and discs cost approx $1.

The audio on the minidisc is recorded to computer using Sonic Foundry's Sound Forge (approx cost - $400). Sound Forge is an audio editor and recorder with a vast range of features to process and correct audio. Any blemishes in the recording can be removed or lessened. There are many similar and cheaper applications that can be used instead. The corrected audio recording is then saved as a digital audio file. This file is then converted to appropriate type that can be used by the streaming software, described below.

Recoding Video to Computer

To record lectures so that they can be streamed requires a video camera and video editing software. Once the video recording has been saved as a computer video file it can be then be converted by the streaming software.

Streaming Audio/Video

For the purpose of this article, streaming can be viewed as the transfer of audio/video over the Internet/intranet without the need for the file to be downloaded. The listener/viewer may request random segments of the recording to be transferred and this will occur with very little delay. By contrast, the usual form of download used is progressive download. The download starts at the beginning of the file and progresses to the end of the file. The listener/viewer is not capable of selecting segments of the audio/video at will; they must wait for the download to complete.There are three steps involved in streaming audio/video - content creation, delivery and playback. Each of these is now described.

Audio/Video Streaming Content Creation
Helix Producer from Real Networks (standard cost - $199, educational licenses are cheaper) is a software package capable of converting audio/video files into a RealMedia file that can be streamed over the Internet/intranet.

This process is known as encoding. When a file is to be encoded, a target audience must be selected. The term, target audience, is used to determine the rate at which a listener/viewer connects to the Internet/intranet, e.g. 56K modem audience and corporate LAN audience - typically, the higher the rate of the target audience, the better the quality of the audio/video. For video, other options, such as the quality of video required, such as smoothness or sharpness can also be chosen. Multiple copies of the same file do not need to be made to suit multiple target audiences. An option called SureStream may be selected and multiple target audiences may be selected for the same file. This file is then placed on the streaming server.

The Streaming Server
To stream the media file just described, Helix Universal Server from Real Networks (standard cost - $1,999, educational licenses are cheaper) is used. It is capable of delivering both on-demand and live media across the Internet/intranet. It is capable of delivering multiple media streams concurrently.

*On-demand streaming***.** On-demand streaming is comparable to watching a video or DVD. The listener/viewer is free to start, stop, pause, forward or rewind as they choose. The media being streamed to one listener/viewer is entirely independent of any other stream from the server. By this I mean, that one listener/viewer (connecting using 56K modem) may be in the middle of *Recording A* while another (connecting using a cable modem) may be at the beginning of *Recording A*. Both streams use the same file, are streamed at a rate suitable for each connection, but in no way impact negatively on each other.

*Live streaming***.** Live streaming is comparable to a television broadcast. The listener/viewer is not free to stop, start, pause, etc. as above. This might be used for the live broadcast of lectures or seminars. A video and microphone would be connected to a computer which has Helix Producer installed on it. Helix Producer creates a stream and sends this to Helix Universal Server, from where it is streamed to the Internet/intranet. Helix Producer can only send this stream to a Helix Universal Server; it cannot stream the audio/video to the Internet/intranet itself. The event being streamed may also be recorded for future on-demand streaming.

Both Real Networks products are available for limited free trail use.

*Alternatives to Real Networks***.** Microsoft offers a similar range of products for streaming audio/video content. The streaming server and file producer are part of the Windows 2000/2003 Server. The cost of this varies depending on the type of server purchased and the number of Client Access Licenses required.

The player for the streaming media, Windows Media Player, comes with all versions of Windows as standard.

Apple's Darwin Streaming Server offers much of the functionality of both Real Networks' and Microsoft's offerings. It, and QuickTime player (the player for the streaming media) are both free.

The Helix Community project is an open source project, initiated by Real Networks, to allow developers to build their own streaming media applications tailored exactly to their needs. Membership and access to the materials (source code, documentation, tutorials) available in the Community are free. However, a very high level of technical skill is needed to make full use of these materials.

Web Server

Along with the Helix Universal Server, a web server is also needed. These two components constitute the audio/video library. The role of the web server is to display web pages for navigation of available content (described below) and to make requests to the Helix Server to stream the requested material. The web server may reside on the same computer as Helix Universal Server, or on another computer. A robust and powerful web server is available from the Apache Group, it is said to be the most commonly used web server in the world and is available free of charge.

Operating System

Helix Universal Server, Helix Producer and the Apache web server are available on a number of different operating systems including Windows, Linux, Solaris and HP-UX. The choice of operating system is one to be made based on available resources and skills. A major advantage that the Unix/Linux (Linux, Solaris, HP-UX, etc) operating systems have is that the whole system (Helix Universal Server, Helix Producer and Apache) can be administered remotely. This is a major plus if there is no one onsite with enough technical expertise to deal with a problem with the system, if one should occur.

Web Pages

The listener/viewer browses all available content in the audio/video library using a web browser. To aid a blind or otherwise reading impaired student, the web interface may include an audio guide that is streamed in the fashion described above. This audio guide plays automatically when the page is opened; it describes how to control the guide, and then the contents of the page. Each item in the contents has a single letter or number associated with it, pressing this letter/number acts in the same fashion as clicking a link. For example, the first page a user encounters might offer a choice between browsing the available books or lectures. The user will be informed that by pressing *B* they will be brought to a new page listing the available books, or pressing *L* will bring them to the available lectures. On this new page, another audio guide automatically plays listing the contents of this page.

Along with the video stream that would be played for lectures, it might be necessary to display graphs and tables at appropriate points during the lecture. This is accomplished using Synchronized Multimedia Integration Language (SMIL). SMIL allows for complex multimedia presentation to be created quickly and easily. SMIL may also be used if a book is describing pictures. It can make the pictures appear at appropriate points in the audio. If a book is describing a piece of music, it can be played.

If there is a large volume of content available, which is being added to frequently, manually creating web pages would be very time consuming and error prone. Instead, the web pages are generated automatically based on the available content. Any media added will be immediately available through the web page. This is done through the use of a Common Gateway Interface (CGI) script, which is able to retrieve a list of all available content on the Helix Server.

When a web page is requested, the script is executed based on the users current location (the web page the user is currently on) and displays only relevant content to the user. For example, if the user is on a page listing available lectures topics, and they choose *physics*, a web page is generated listing just the physics lectures.

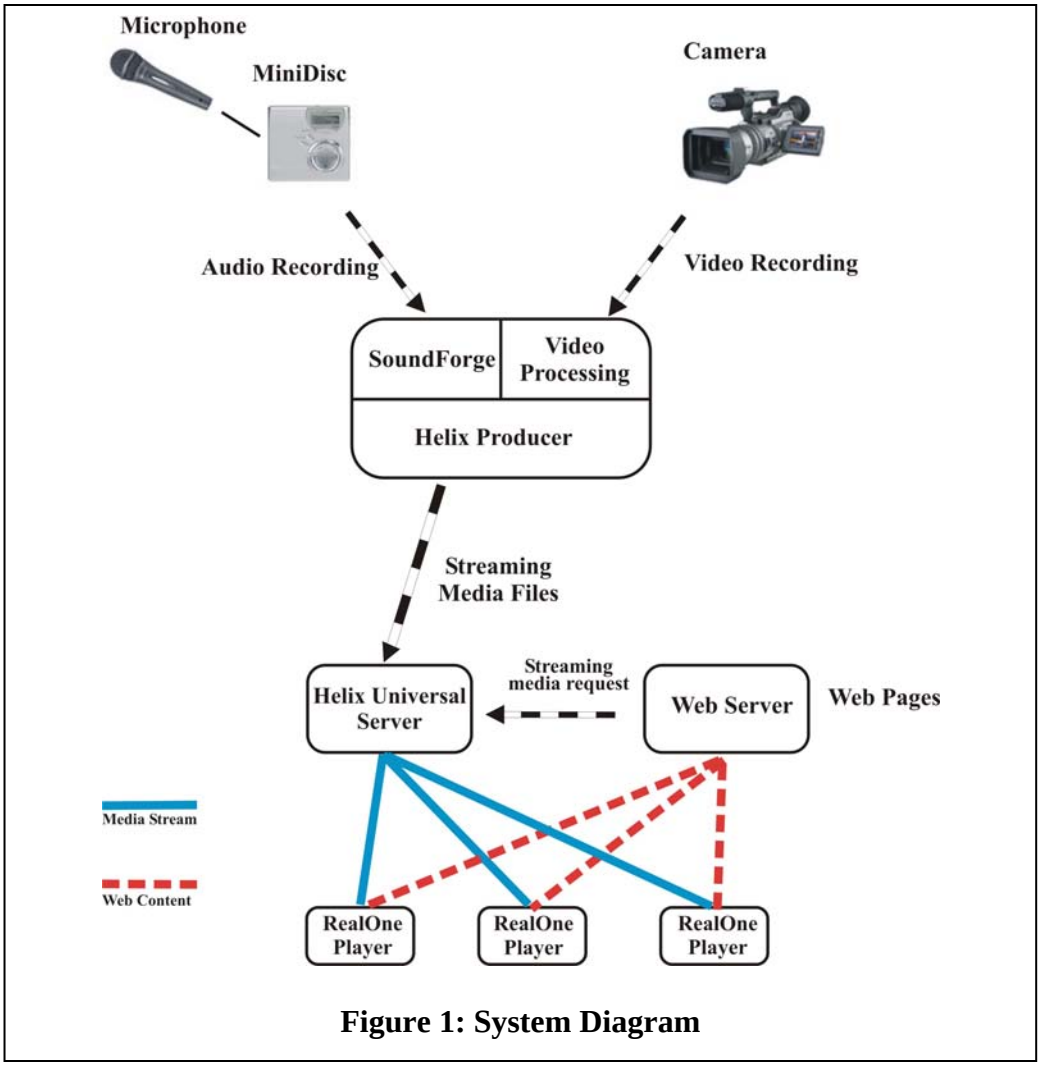

Figure 1: System Diagram

RealOne Player

RealOne Player from Real Network is the application that plays the audio/video stream received from Helix Universal Server. Each listener/viewer must have this application on their computer, along with a soundcard. RealOne is simple to install and use, and is available free from Real Networks. It is also capable of functioning as a web browser.

The above figure *Figure 1: System Diagram* shows how the source audio/video progresses through the various steps to the end user.

The figure *Figure 2: Standard User Interface*, below, shows how the available material is presented to the user. The box below the title *Lectures* is the embedded RealOne player, here it is playing a stream describing how to control the playing audio, the contents of the page and the keys associated with each link. To the right of the player are the keys that control the streaming audio. Below this are the available topics, each can be navigated to by pressing the associated key or clicking on the link.

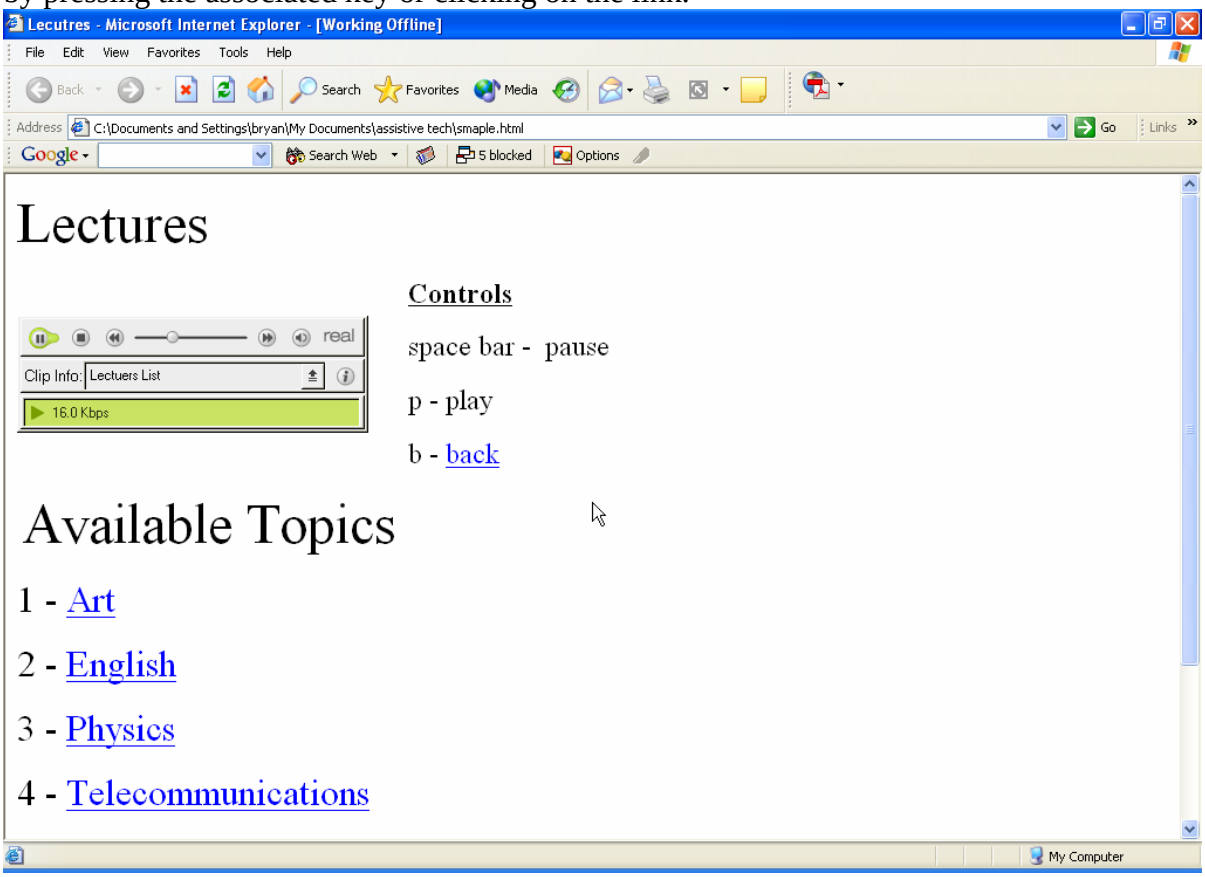

Figure 2: Standard User Interface

Linking audio/video libraries

The system described in this article is easily replicated. Identical systems can be set up in many educational institutes spread over a small or large geographical area. If this were to

happen, all the audio/video libraries and streaming audio servers could be linked together to provide a very wide range of texts and lectures.

Ideally, the effort of recording books and lectures would be in some manner coordinated, so that institutions do not duplicate the effort of recording the same material.

Alternate interface options
The web interface described above requires that the user be capable of using a mouse or pressing a key on the keyboard. However, for many students, this is impossible. In these cases, other interface options may be deployed.

Voice recognition software can be used for browsing. Again, software is easily available, but usually has to be trained to understand the user's voice. This is acceptable if the user is always using the same computer, but presents a problem if not. Another problem is that voice recognition is not always accurate.

Certain web cameras allow the user to control the mouse pointer by moving their hands in space in front of the camera. Given that a person who is not able to use a mouse will probably not be able to fully control their hand movements, the web pages displaying the available texts/lectures will have to be customised to suit such users. This might mean reducing the number of available links on a page and making the links much larger and apart from each other.

Customisation. The type of interface used can be customised for each user. When they logon to the system, they are presented with an appropriate web page to match their needs. They are also shown only the list of book and lectures that are of interest to them, the option of browsing all available books/lectures can also be made available. The student can bookmark the point at which they are at in each book/lecture so that they can easily return to the same point at a later time.

Further Educational Options
The applicability of the technology and methods has far greater scope than so far described. Many branches of an educational institute can be made available to students who are unable to physically attend the university.
Below are some additional applications that the technologies could be used for.

Text Library
Along with the audio versions of a text, it is possible to make available print versions via the Internet/intranet by scanning the pages of the text into a computer file. With the use a screen reader, this could be accessible to vision impaired students.The following applications would be of use for students with physical disabilities that prevent them from attending the institute.

Seminars
Standard video conferencing technology can be used to include students who are unable

to attend seminars. They can both view and contribute to the seminar.

Meetings with lecturers
Again using standard video conferencing technology it is possible for a student to *meet face to face* with a lecturer.

Tutorials
In a similar fashion to seminars, students can receive tutoring in a one to one manner using video conferencing.

Other Issues
The various technologies described in this article are easily obtained and in common use. The technical difficulty in deploying such a system is quite low. The author has found that the main challenge is associated with the organisational aspects of this system. These include choosing appropriate material to record so as to be of the greatest benefit to the widest range of students. Only certain chapters from a book may be required by students, but lecturers have been unwilling to provide such information.

The information systems department has to make the client software available on computers within the institute. Their assistance may also be needed to make the system available from anywhere on the Internet. A panel of reliable, high quality readers needs to be developed. This can be difficult as many people think that recording a book would be easy, and find the opposite to be true. Training may need to be provided to teach readers the best methods for recording a text. The recorded texts from each reader need to be screened, initially at least, to assess the quality of the material.

Deploying the system across multiple institutes leads to further organisational difficulties. Co-ordination is essential so that recording work is not duplicated. The information systems departments may also need to liaise to connect the Helix servers.

Overall, the author’s opinion is that there is a need for management to support such a project and request co-operation from all groups needed to deploy the system successfully.

Conclusion
This article presented a description of how to deploy off the shelf software and hardware components to give students with disabilities a better level of access to education through the use of an audio/video streaming library. It began with how to record texts and lectures, and how these could be broadcast on the Internet/intranet. It then described how this system could be replicated in many institutes and that these could be linked together. A small range of other applications that can be developed using the described technology was given. Finally, some organisation aspects of the deploying this system were given.